Third United Nations International Conference on the Peaceful Uses of Atomic Energy

A/CONF.28/A/328
USSR
February 1964
Original: RUSSIAN

Confidential until official release during Conference

Abstract

HEAT TRANSFER IN LIQUID-METAL-COOLED REACTOR ELEMENTS

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In spite of some progress in theory the experimental studies of heat rransfer to liquid metal remain for the present the main research methods.

This report gives new data on heat transfer to liquid metals obtained recently with the development of liquid-metal-cooled reactors.

As a result of temperature distribution measurements in the flow of sodium, sodium-potassium alloy, lithium, mercury, a general equation for temperature distribution in different liquid metals was obtained, addy diffusivity heat transfer coefficients in round tubes were determined and also some statistical characteristics of turbulent flow were evaluted.

In studying free convection effect it was noted that the well known McAdams rule could not be applied.

In this report the problems of heat transfer in slab fuel elements are considered. These elements are characterized by enlarged heat exchange surface. Analytical calculations and experimental studies revealed some specific features of heat transfer in rectangular cross section ducts. Data for extimation of channel geometry, fuel layer and shell thickness and their thermal conductivity, etc. were obtained.

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The problems of heat transfer to liquid metals in parallel flow through bundles of circular rods are considered, empirical equations for circumferential temperature distribution calculation of such fuel elements are given. The temperature distribution in bundles of fuel elements is shown to depend also on their properties (thermal conductivity, sizes, etc.).

It was proved that equivalent hydraulic diameter did not apply to generalization of heat transfer coefficient values for liquid metals in complicated cross-section ducts.

Circular fuei elements are classified according to their thermal properties and the possibility of thermal simulation under laboratory conditions. Methods of circular fuel element thermal simulation are described.

Comparison of experimental results for heat transfer to liquid metals and water in parallel flow through bundles of circular roods is given . The use of equivalent hydraulic diameter as a typical size of bundles through which water or some other ordinary liquid flow is noted to be not crear enough.

An approximate method of temperature distribution calculation for circular element bundle based on the analysis of uniform velocity liquid flow (slug flow) is considered. In some cases these results give a sufficiently correct physical picture.

This report presents the results of the investigation of average heat transfer coefficients in shell-and-tube heat exchangers of "liquid metal-liquid metal" type with different lattice pitches and with different lengths of the tubes. It is shown that average heat transfer coefficients in heat exchangers and in fuel element bundles must differ from one another.

Investigation of pressure drop in fuel element bundles

allowed to reveal some inherent features of these systems (e.g. significant decrease of friction factors in close-packed bundles, etc.).

As a result of sufficient number of heat transfer to liquid metals experiments with cross flow through tube bundles average heat transfer coefficients may be calculated. However pulsation amplitudes of heat-exchange surface temperature that amount 40 to 60% of average temperature drive excite appreheusion as to reliability of durable work of some of these systems.

The results of experimental heat transfer studies when changing aggregate conditions of liquid metals are given. Investigations of heat transfer coefficients and burnout heat flux rate in the case of bailing natrium under free convection conditions revealed some inherent features of liquid metal boiling (pressure pulrations, different boiling conditions, etc.)

Condensation processes of potassium vapours were studied on flat vertical wall. Visual observations and photographs showed some peculiarities of substitution of droplet condensation by film one.